Use of simple morphometric condition indices in North Atlantic fisheries: the example of anchovy, mackerel, white and black anglerfish.

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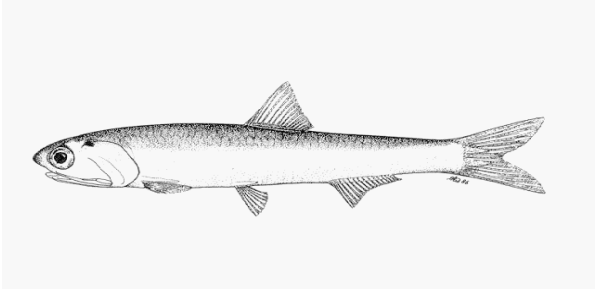
Biological parameters of the European anchovy (*Engraulis encrasicolus*) year classes during 1990-2011 in the Bay of Biscay



One of the main objective of this study was to analyze the inter-annual variability of some biological traits of the Bay of Biscay anchovy between 1990 and 2011:

Å Through exploration in changes of the **condition status** of individual **year classes** of this species.

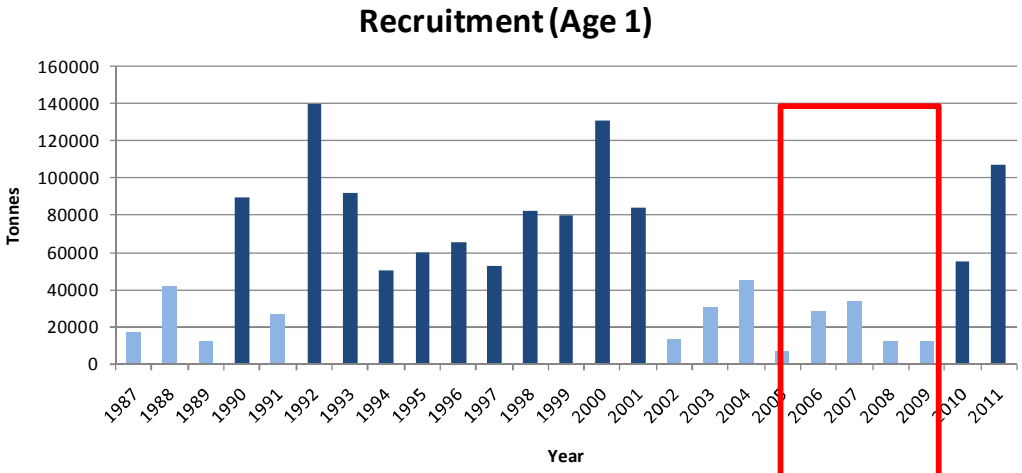
Background

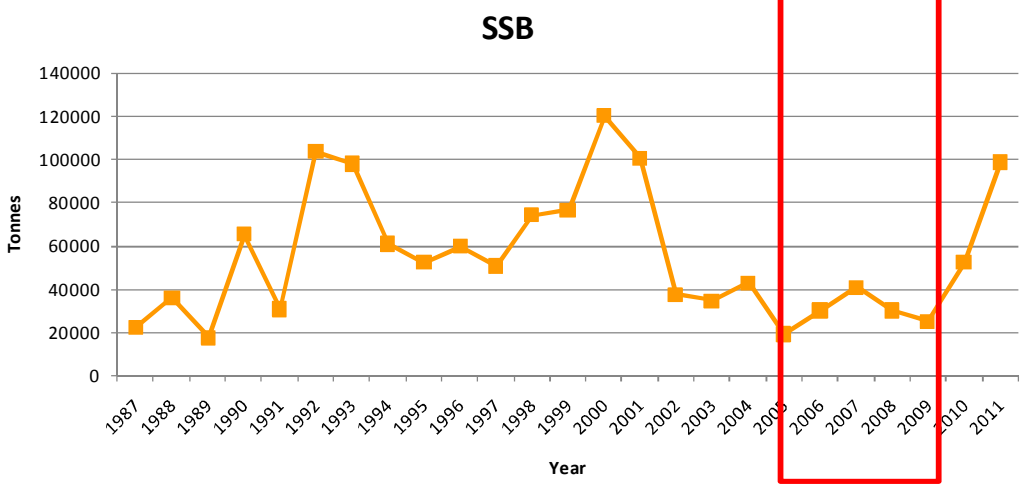
Several **recruitment failures** took place in the Bay of Biscay anchovy population since 2001, specially the recruitment of the 2004 year class, the lowest in the historical time series (ICES, 2011).

As the population is based in few age classes (mainly 1-3) these failures has resulted in a **declined of its population** until it collapsed in 2005, with the consequent **closure of the fishery** until 2009.

In 2010, and specially in 2011, the SSB has been estimated above Blim implying a recovery of population levels respect to the previous 5 years. Such a **recovery** reflects the good recruitment of 2009 and 2010 year classes, the most abundant since that of 2001.

Therefore a precise knowledge of biological characteristics and its effect of year classes is very important



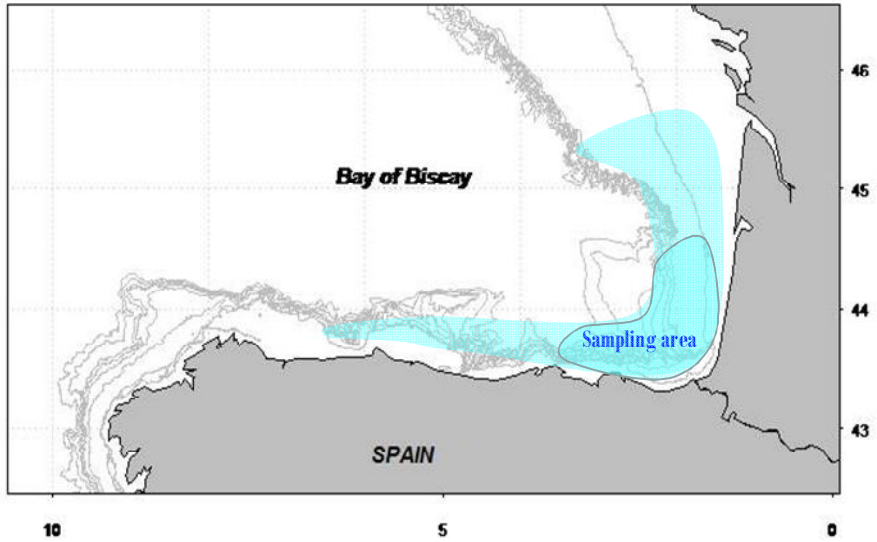


Fishery closed

Material & Methods

Biological samples:

From commercial landings in the Bay of Biscay between 1990-2011 (17446 specimens).



Data analysis:

Condition Factors:

Å **Fulton's** CF= (Wt /Lt^3)* 100

Å **Le Cren's** CF= $Wt/a*Lt^b$

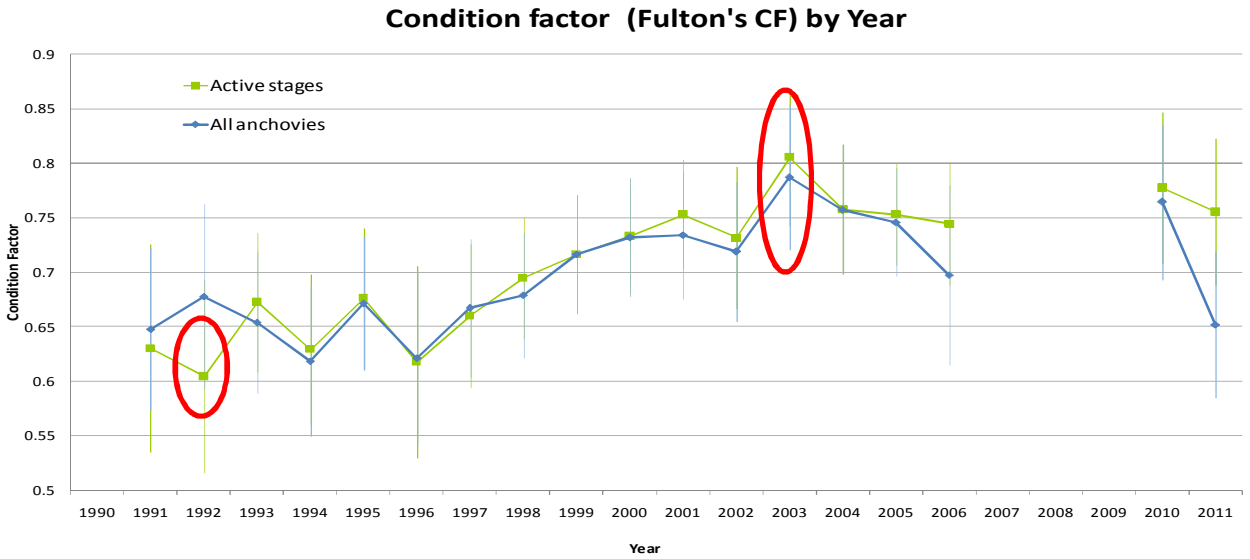
Wt = Total weight (g); Lt = total length (cm); a, b = parameters of the regression (Weight-Length)

As mean of the CF for all anchovies and for anchovies in active stages for each year class during spawning season.

Results & Conclusion

Condition Factor (Fulton´s CF)

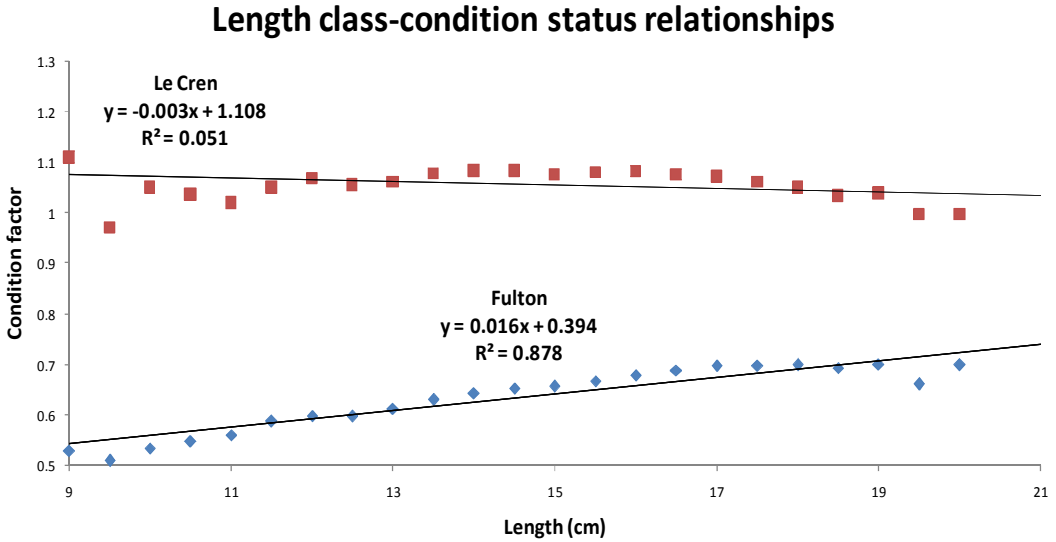
The mean Condition Factor (CF) show a maximum values in 2003, and minimum values in 1992 (active stages).



Fulton's and Le Cren's CFs were compared and showed differences.

Fulton's CF by size class showed an increasing trend with size

Le Cren's CF was not affected by size, which determined its suitability for the purposes of the present study.



Results & Conclusion

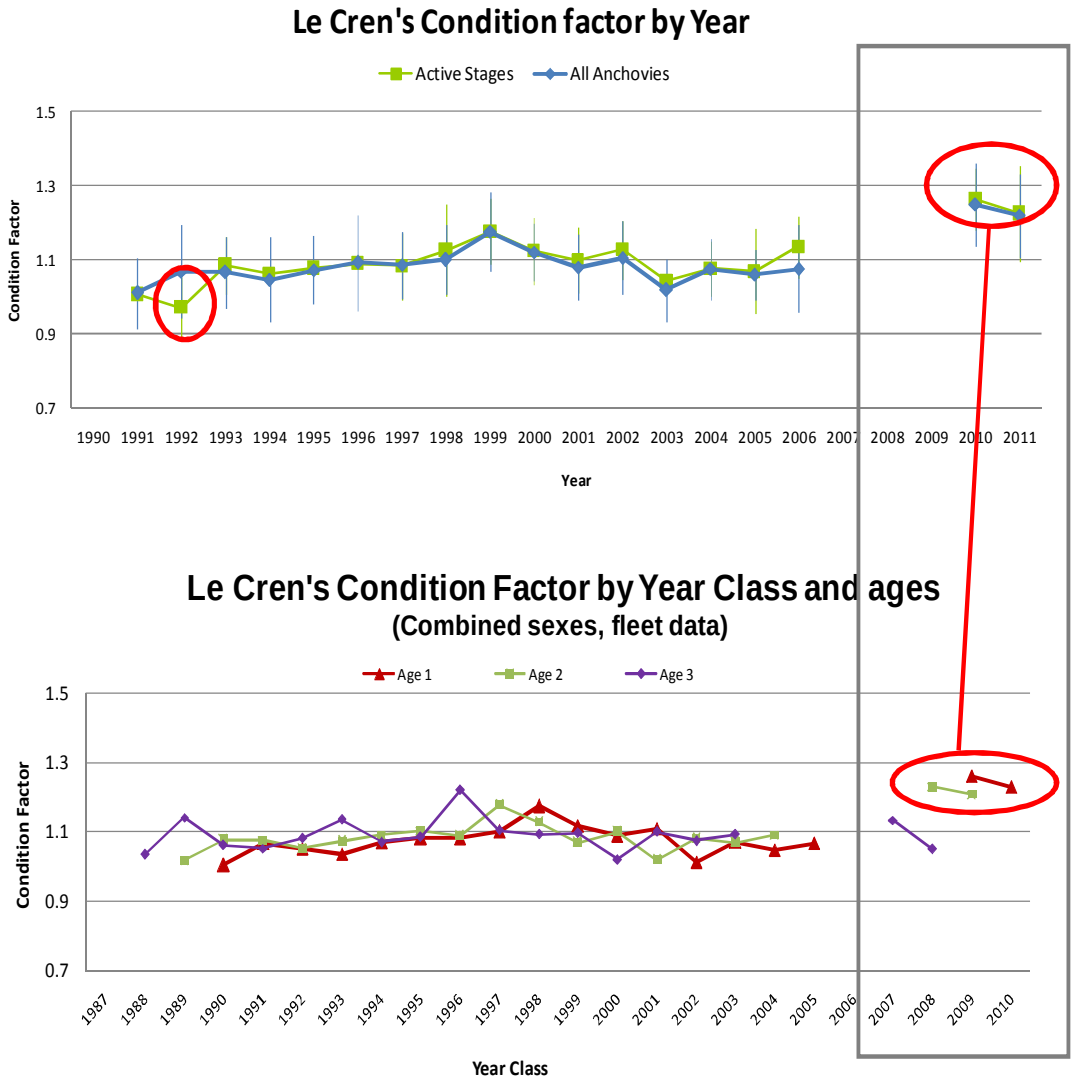
Condition Factor (Le Cren's CF)

Le Cren's CF shows **similar** values during all the time series **except in 2010-2011**, where a higher CF was found. In **1992** (active stages) were a CF lower values.

CF by year class

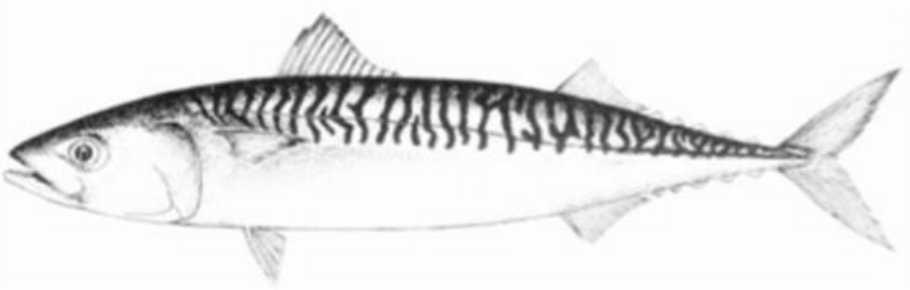
The highest CF is observed in the age 2 (2008 & 2009 year class) and age 1 (2009 & 2010 year class).

There were several features that took place in the biology of the anchovy cohorts born during the **last period of collapse** and **recovery** of the population and one was the increasing of the **condition factor** in **2010-2011**, where a **higher** CF was found.



Period of Recovery stock

Changes in the timing of spawning of the southern component of the Northeast Atlantic Mackerel (*Scomber scombrus*), 1990-2010



One of the objective of this study was to analyze the spawning seasonality of mackerel and its inter-annual variations in the period 1990-2010:

- Through exploration in changes of **gonadosomatic index** and **condition status** of individual **year classes** of this species.

Also, we investigate the impact of environmental conditions on these changes.

Background

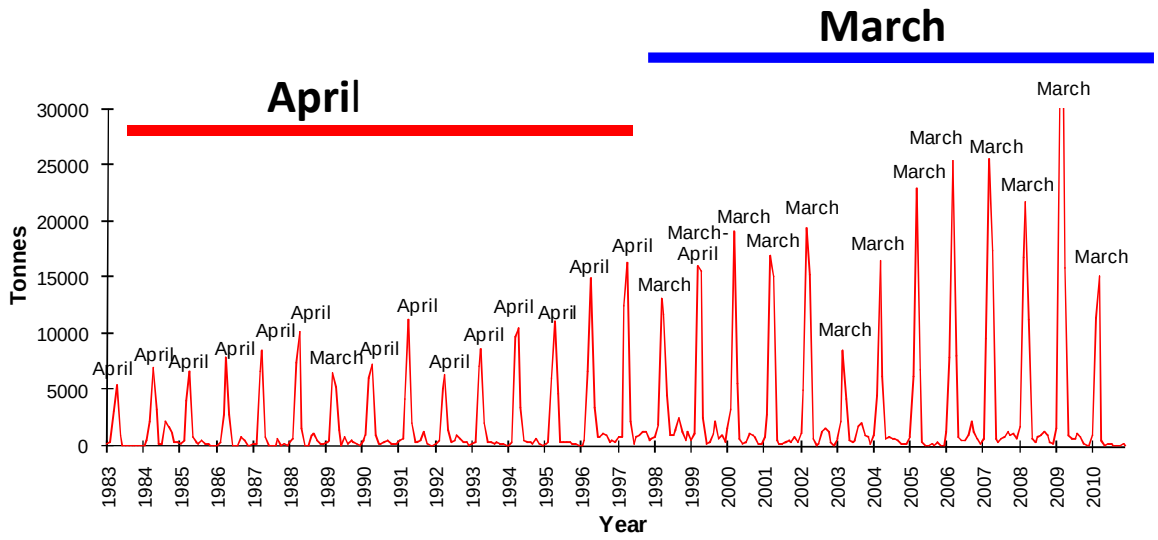
- Mackerel migrate to the spawning ground of the Southern area in the first half of the year (Uriarte et al., 2001). In this season the greatest mackerel concentrations are found in the Cantabrian Sea.

Å The spawning in the Cantabrian Sea takes place from **February** to **June**, with a peak in **April**.

- The annual start of the Spanish mackerel fishery in the Cantabrian Sea and northwest is determined by this migration (Villamor et al., 1997; Punzón et al., 2004; Villamor, 2007).

- Until 1997 peak catches appeared in **April** (Villamor et al., 1997; Villamor, 2007).

- From that year on, a change has been seen in the development of the fishery, and the largest landings are now made in **March**.



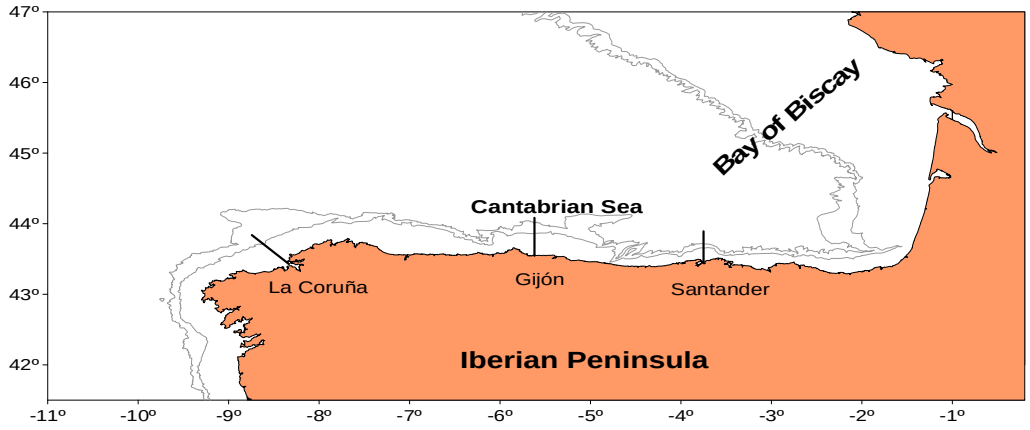
Material & Methods

Spawning seasonality was determinate from the analysis in Division VIIIc-Cantabrian Sea, main spawning ground of the Southern area:

- **Monthly mean gonadosomatic index**
  - **GSI = (WG / Wg)* 100** (for 1998, 2004, 2007 and 2010, with gonad and gutted weight available)
    WG= gonad weight (g), Wg = gutted weight (g);
- **Monthly mean condition factor:**
  - Fulton's condition factor
    CF = (Wg/ Lt^3)* 100 (for 1998, 2004, 2007 and 2010, with gutted weight available)
    Wg = gutted weight (g) , Lt = total length (cm)
  - Fulton's condition factor
    CF = (Wt/ Lt^3)* 100
    Wt = Total weight (g) , Lt = total length (cm)

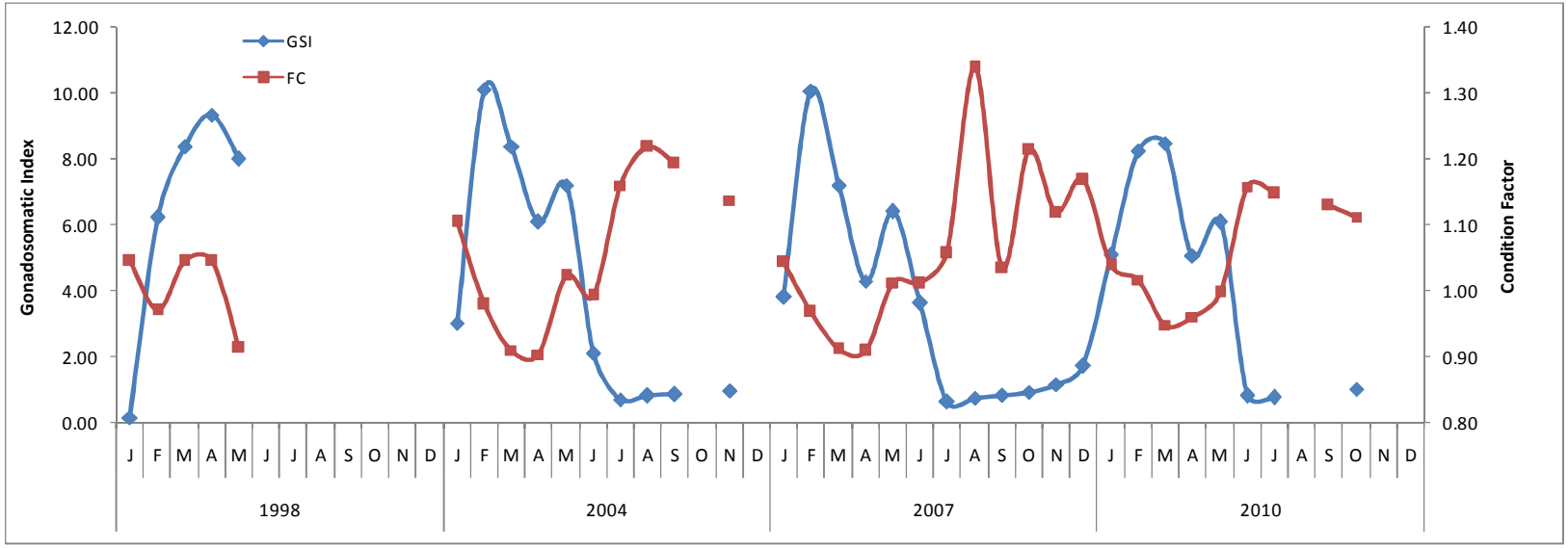
Meteorological and hydrological data:

- **Sea Surface Temperature** representative for the area from the NOAA Optimum Interpolation SST (Reynolds et. al, 2002)



Results & Conclusions

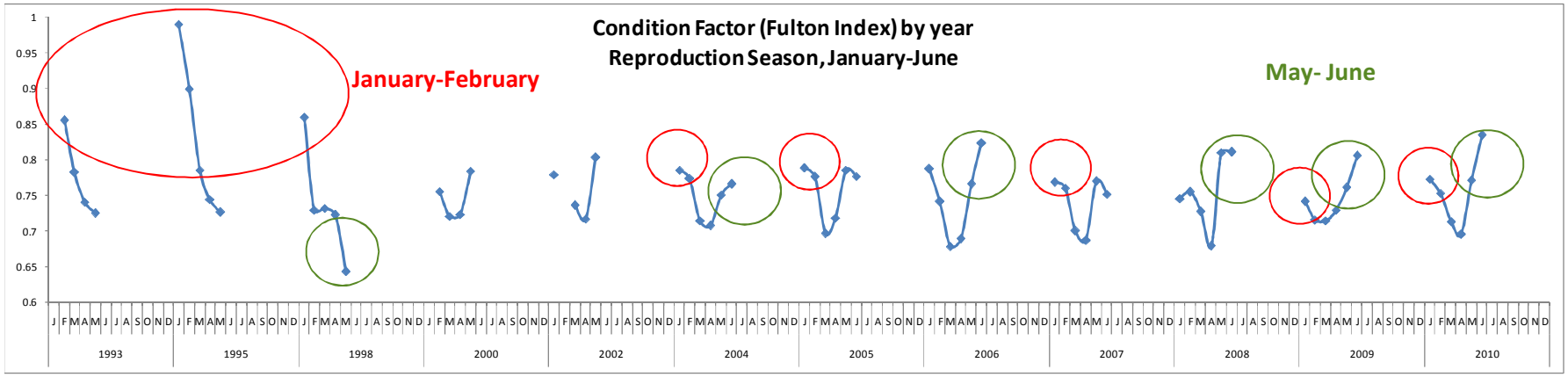
Gonadosomatic Index (GSI) and Condition Factor (CF)



The analysis of monthly values of the GSI (blue) and CF (red) indicators verified the behavior and **seasonal fluctuation** of both indices.

Results & Conclusions

Condition Factor (CF)



Analysis of the monthly values of Fulton's CF for the historical series of 1990-2010 in the spawning season (January-June) shows that the values of FC in **January** and **February** are **higher in 1990s**(range 0.80- 0.99) than in the 2000s (range 0.72- 0.86).

However, the values of CF in **May-June**, **are higher in the 2000s** (from 0.75 to 0.82) than in the 1990s (0.64 to 0.72). Also in 2000s the CF shows a recovery of the fish condition in May-June compared to the previous months.

This indicates that **in the 2000s**, mackerel **begins spawning before** and **also ends before**, in relation to the **1990s**

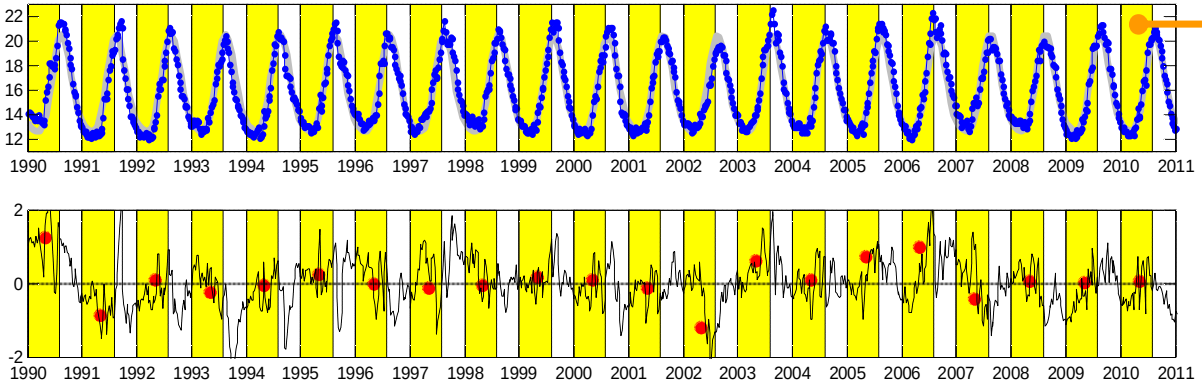
Results & Conclusions

Environmental Factors 1990-2010

Seasonal changes in SST

a)

b)



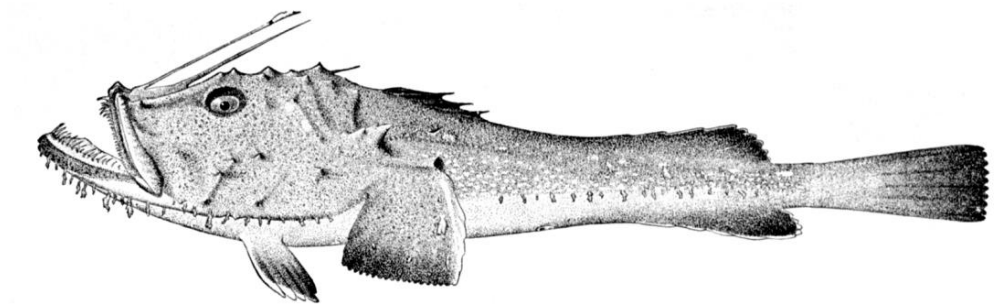
a) Weekly SST at the southern Bay of Biscay

b) Anomaly of SST (black) and average for the winter-spring (red).

Higher temperatures in winter-spring are noted in the 2000s respect to the 1990s. Some years in the 00`s show an advancement of the spring .

All in all, it can be said that during the **2000s the winter** tended to be **warmer** and **the spring** tended to **start earlier**.

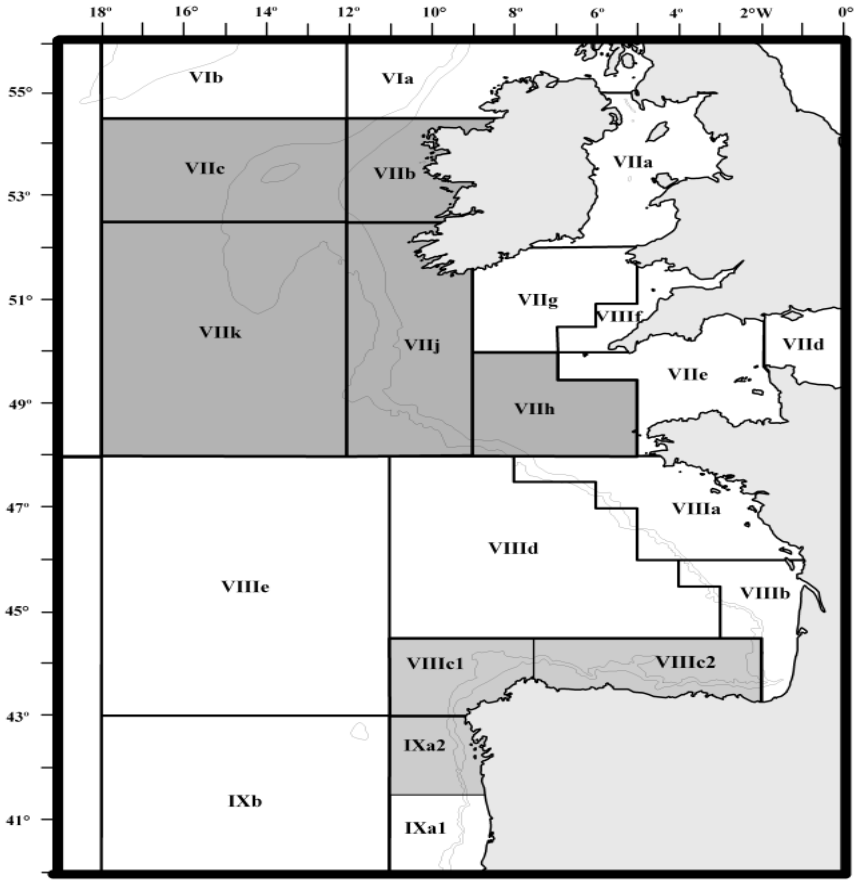
Condition factor trends for two stocks of white and black anglerfish (*Lophius piscatorius* and *Lophius budegassa*) in southern Bay of Biscay, Galician waters and northern Atlantic areas from a decade



The objective of this study was to analyze the evolution of the **condition factors** of white and black anglerfish (*Lophius piscatorius* and *Lophius budegassa*), both important species in European bottom fisheries in Atlantic waters

MATERIAL & METHODS

Samples were collected mainly from periodical samplings of landings of Spanish commercial vessels in northern Iberian Atlantic waters (ICES Div. VIIIc-IXa2) and in Celtic Sea, south-western Ireland and Porcupine Bank (Div. VIIb,c,j,h,k).



The sampling period was **a decade** (January 2006-December 2015) and the collected data from each specimen analyzed in this study were:

Lt: total length (cm)

Wg: gutted weight (without liver)(g)

L. piscatorius = **6401** specimens

L. budegassa = **3130** specimens

MATERIAL & METHODS

Condition factor

Le Cren's (1951) relative condition factor (K) was quarterly estimated because no enough monthly data were available.

K was analysed over one-year period, pooling the ten sampled years.

$$K = Wg / a\ Lt^{b}$$

Wg = gutted weight (g); Lt = total length (cm); a, b = parameters of the regression (Weight-Length)

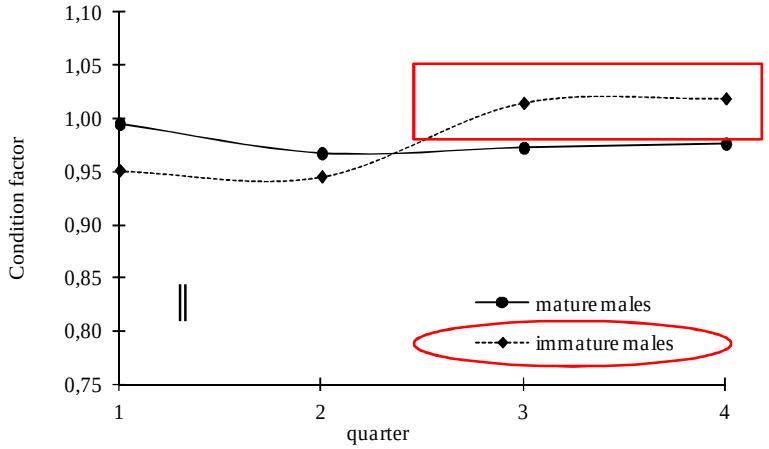
Four **comparisons** of the condition factor (CF) were made among:

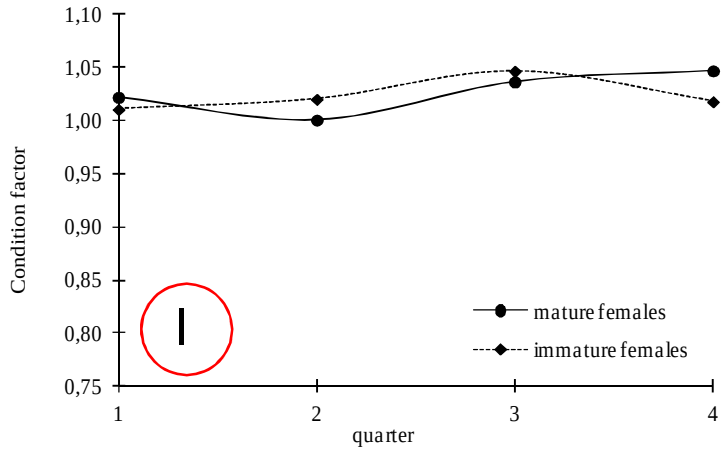
- **Stocks**
- **Sexes**
- **Immature and mature**
- **Quarters**

RESULTS

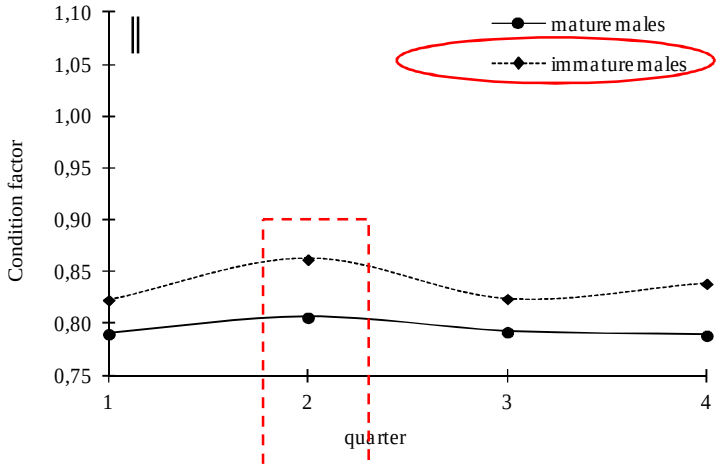
Evolution of the **condition factor** for ***L. piscatorius***

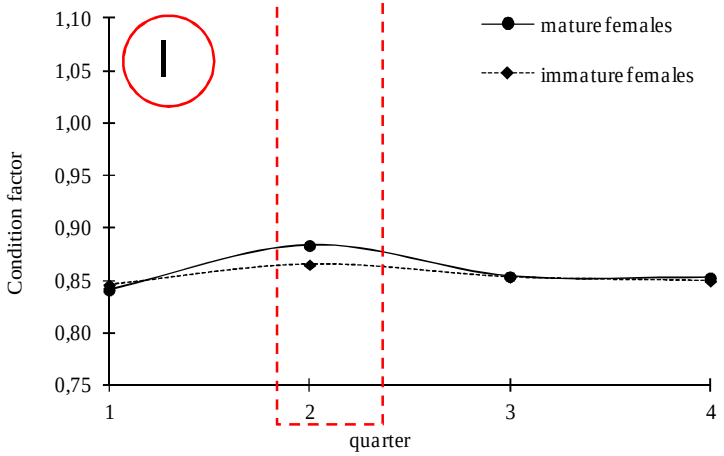
VIIb,c,h,j,k





VIIIc-IXa





RESULTS

Condition factor (K) *L. piscatorius*

Comparison between stocks

Significant differences ($p<0.05$) in K between both areas were found, showing better condition in Div. VIIb,c,h,j,k in both sexes

Comparison between sexes

Significant differences ($p<0.05$) in K between sexes were also found, with better condition in females in both stocks studied.

Comparison between mature and immature

Significant differences ($p<0.05$) in K between mature and immature specimens were found for males, with better condition in immature males

No significant differences ($p>0.05$) were obtained between mature and immature females.

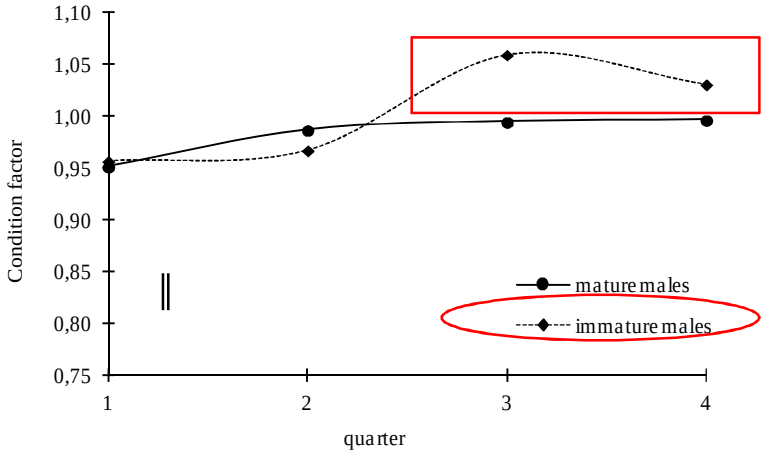
Comparison among quarters

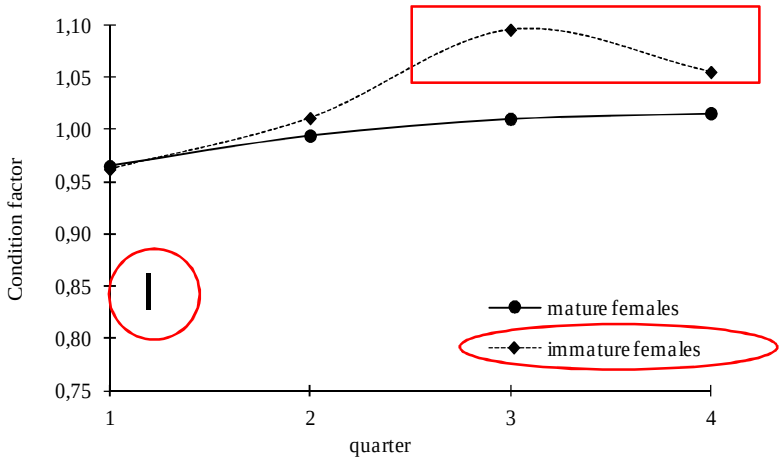
In Div.VIIb,c,h,j,k, no significant difference ($p>0.05$) were found among quarters in both sexes, except for immature males, with a significant better condition in the second half of the year ($p<0.05$). In Div. VIIIc-IXa, better condition in the second quarter ($p<0.05$)

RESULTS

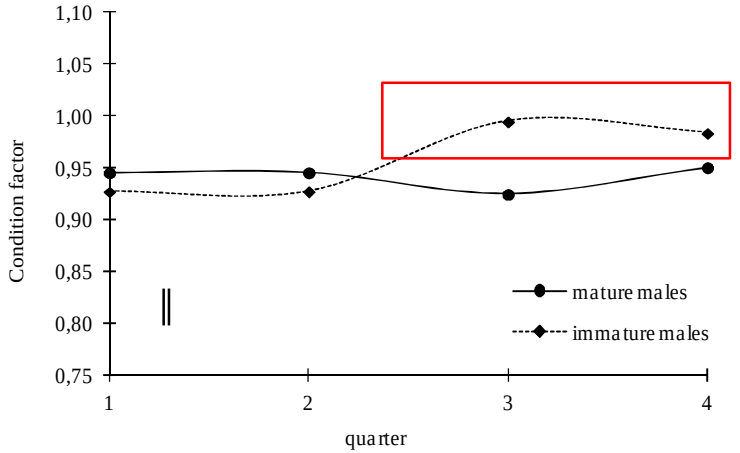
Evolution of the **condition factor** for ***L. budegassa***

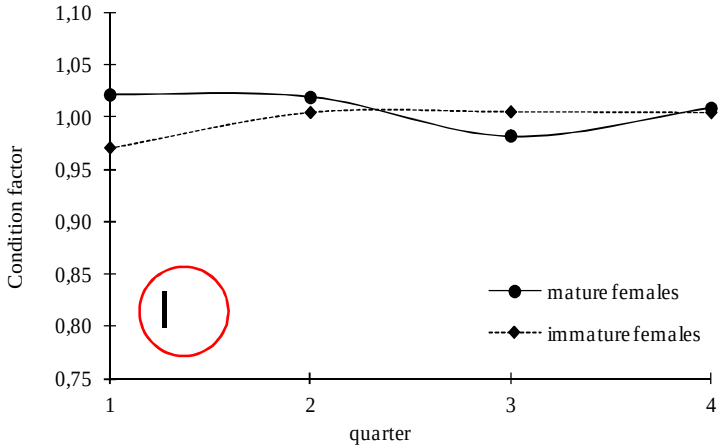
VIIb,c,h,j,k





VIIIc-IXa





RESULTS

Condition factor (K) *L. budegassa*

Comparison between stocks

As in the other species, significant differences ($p<0.05$) in K between both areas were found, showing better condition in Div. VIIb,c,h,j,k.

Comparison between sexes

As in the other species, significant differences ($p<0.05$) in K between sexes were also found, with better condition in females in both stocks studied.

Comparison between mature and immature

Significant differences ($p<0.05$) in K between mature and immature specimens were found, with better condition in immature males and females, in Div. VIIb,c,h,j,k.

Comparison among quarters

In Div.VIIb,c,h,j,k, similar results to those of white anglerfish were found, showing no significant difference ($p>0.05$) in mature specimens of both sexes, but better condition was found in the second half of the year ($p<0.05$) for immature specimens.

CONCLUSION

The **similarity in the condition for mature individuals of both species** throughout the year may be **related to** the **extended spawning period** of anglerfish, especially remarkable in males, with mature individuals for almost the entire year (Duarte *et al*., 2001).

Immature individuals of both sexes and stocks, mainly black anglerfish, seem show an overall better condition mainly in **summer** and, not so remarkable, in autumn. Immature specimens do not transfer energy to gonad development, but the good condition in summer may be related to the best environmental conditions and food intake that may favor a more active metabolism.

In both stocks, these seasonal differences could be due to transference of energetic reserves to the gonadal development in mature individuals, while that energy in immature individuals would be reflected in a better condition.